DISCARDING PRACTICES IN THE GULF OF MEXICO SHRIMP FISHERY

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R.J. BERRY and R.C. BENTON

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RICHARD J. BERRY and ROBERT C. BENTON
Bureau of Commercial Fisheries, Biological Laboratory
Galveston, Texas 77550

CONTENTS

Abstract

Studies were conducted to determine the causes and extent of shrimp discarding on the Tortugas pink shrimp and Texas brown shrimp grounds. Information was obtained from direct observations on commercial fishing vessels and from interviews with shrimp fishermen. Discarding declined markedly on the Tortugas grounds from 1963 to 1966, apparently due to increases in the value of small shrimp. Other factors, including the reluctance of processors to purchase small shrimp and a minimum size restriction, appear to influence discarding practices on offshore Texas grounds.

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LE REJET A LA MER DANS LES PECHERIES DE CREVETTES DU GOLFE DU MEXIQUE

Résumé

La communication rend compte d'une étude tendant à déterminer les motifs et l'importance des rejets de crevettes à la mer dans les pêcheries du golfe du Mexique, les espèces visées étant la "crevette rose" (Penaeus duorarum Burkenroad), récoltée dans la zone des Tortugas, et la "crevette brune" (Penaeus aztecus Ives), pêchée au large du Texas. Les renseignements ont été obtenus par observations effectuées à bord de navires de pêche commerciale et interrogatoires directs de pêcheurs. De 1963 à 1966, la pratique du rejet à la mer a nettement diminué dans la pêcherie des Tortugas, apparemment en raison du relèvement des cours des petites crevettes. Pour ce qui est des fonds de pêche au large du Texas, le rejet à la mer paraît être influencé par d'autres facteurs, notamment le peu d'intérêt manifesté pour les petites crevettes par les transformateurs, et l'imposition d'une taille minimale.

CAPTURA DESECHADA EN LA PESQUERIA DE CAMARONES DEL GOLFO DE MEXICO

Extracto

Se realizaron estudios para determinar las causas y la proporción del camarón devuelto al mar en los caladeros de camarón rosado de las islas Tortugas y en los de camarón marrón de Texas. Se obtuvo información de las observaciones directas realizadas en las embarcaciones de pesca comercial y de las entrevistas sostenidas con los pescadores de camarones. La cantidad de camarón desechado disminuyó bastante en los caladeros de las Tortugas desde 1963 a 1966 debido, al parecer, al aumento de valor del camarón pequeño. En el desecho de camarón en los caladeros de las costas de Texas parecen influir otros factores, como la resistencia de los elaboradores a comprar el camarón pequeño y las restricciones sobre la talla mínima.

1 INTRODUCTION

An important, but seldom measured, element of many commercial fisheries is the portion of the catch that is discarded at sea. Unless the species of interest survives after being caught and thrown back, the resource is diminished with no direct gain to man. Discarding can be of particular significance if the gear used in a fishery commonly takes individuals that are too small to be marketed.

The practice of culling and discarding small shrimp apparently is widespread in the shrimp fishery of the Gulf of Mexico, but the subject has received little attention in the literature. Reports from fishermen indicate that the number of shrimp discarded from different catches is extremely variable, ranging from none to two-thirds of those landed on deck. Iversen and Idyll (1959) reported that on the Tortugas grounds near Key West, Florida, 36 percent of the number of shrimp caught by a chartered research vessel was culled by the fisherman-captain during simulated commercial operations. They noted also that a greater proportion of the catch might be discarded if a fisherman was seeking large shrimp where small shrimp were abundant. Iversen, Jones and Idyll (1960) concluded that small shrimp are culled only when few are caught, and it is not worth the effort or expense to ice them separately from the rest of the catch.

Our endeavours to obtain further information about the extent and causes of discarding began in the summer of 1962. Fishermen reported that large quantities of small brown shrimp were discarded in areas off the Texas coast in July and August of that year. In mid-August and on several later occasions, a biologist accompanied commercial fishermen to observe culling practices at sea. The time required to carry on such observations made it apparent that another approach was needed if we were to obtain more than general information about the subject. Beginning in September 1963, we started an interview survey of fishermen who landed shrimp at certain ports to determine the approximate weight of small shrimp that they discarded at sea. This report presents the results of these investigations and discusses some of the causes of discarding.

2 CONDITIONS THAT AFFECT DISCARDING

A fisherman's decision to keep or discard the small shrimp in his catch is probably influenced by several considerations, most of which are well known to persons familiar with the shrimp fishery.

2.1 Availability of small shrimp

The time of year when small shrimp are available to the fishery depends on the species and on laws governing harvests. The commercial fishery in the Gulf of Mexico is supported by three species: the brown, Penaeus aztecus Ives; the white, P. setiferus (Linn.); and the pink shrimp, P. duorarum Burkenroad. Each spawns in offshore Gulf waters and the young enter coastal bays as postlarvae. Generally, brown and pink shrimp return to offshore waters sooner and at a smaller size than white shrimp. Landing data are portrayed in Fig. 1 to show the seasonal availability of small shrimp of the three species. (The term small shrimp, as used here, refers to those numbering 68 or more to the lb (150 or more /kg) with heads removed).

The fishery operates both in estuaries and offshore, if local conditions and statutes permit. Because shrimp move seaward during the juvenile or subadult stages, the size composition of catches varies with depth and distance from shore; the proportion of small shrimp landed is greatest when fishing is concentrated near the coast.

2.2 Value of small shrimp

The value of small shrimp must play an important part in determining a fisherman's attitude toward discarding, but data are not available in the literature to verify this point. Considering all U.S. landings from the Gulf of Mexico, no significant relation is apparent between average ex-vessel prices and annual landings of small shrimp (Table

I). At a particular port, however, value would be expected to decrease when supply exceeded demand.

TABLE I

Average ex-vessel price and total weight of small shrimp (68 or more per lb) caught in the Gulf of Mexico and landed at U.S. ports, 1956-66

Year	Average price per lb	Weight of small shrimp landed	Small shrimp in total landings
	(U.S. cents)	(Millions of lb)	(%)
1956	28.6	17.8	16.4
1957	32.4	11.4	11.5
1958	35.0	10.9	10.7
1959	23.6	12.8	11.4
1960	25.8	13.7	11.4
1961	30.3	9.4	12.1
1962	38.5	16.4	18.9
1963	20.0	19.8	15.6
1964	26.7	14.7	13.0
1965	29.4	21.8	17.9
1966	36.9	22.8	20.3

Source: Gulf Coast Shrimp Data, Current Fishery Statistics, U.S. Fish and Wildlife Service and Shrimp Landings, Current Fishery Statistics, U.S. Fish and Wildlife Service

Shrimp prices have fluctuated considerably in recent years, probably in response to changes in landings, holdings, imports, and the level of the nation's economy. A comparison of prices paid for large and small pink shrimp in 1958-66 (Fig. 2) indicates that the value of small shrimp is determined largely by the same factors that influence the prices of larger shrimp. Differences between the curves for the two sizes may result from the fact that two markets are involved; most small shrimp are canned, whereas large ones usually are frozen. The price paid for small shrimp in 1958-66 varied by a factor of three, ranging from a monthly average of about 15 to 45 cents per lb (33 to 99 cents /kg).

2.3 Methods of grading

The value of shrimp to the fisherman depends on the size composition of the catch and on the method used to determine size. Landings are purchased according to the num-

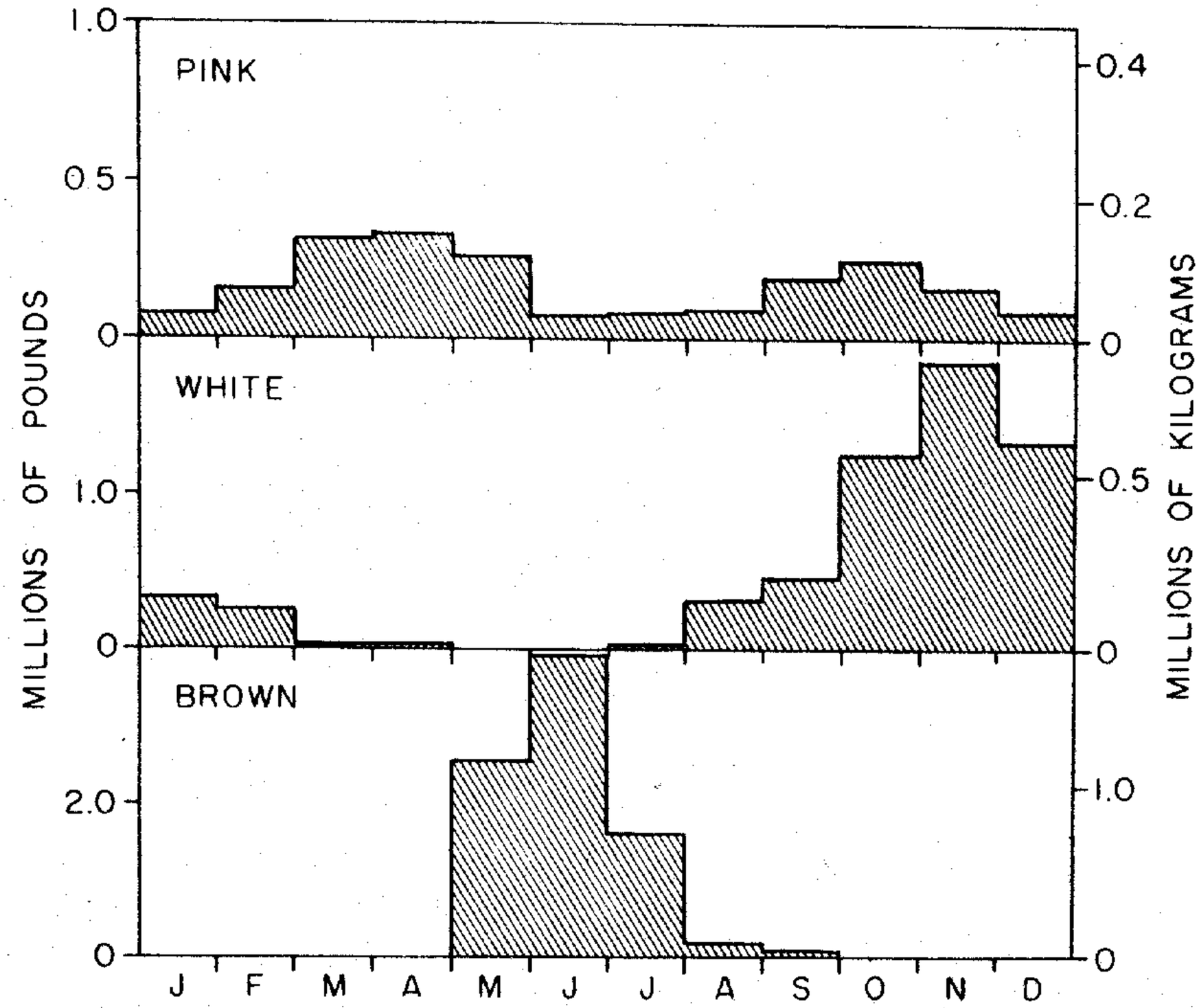

Fig. 1 Average monthly landings (1961-65) of small shrimp (68 or more per lb (150 or more/kg)) from United States waters in the Gulf of Mexico. Source: Gulf Coast Shrimp Data, Current Fishery Statistics, U.S. Fish and Wildlife Service.

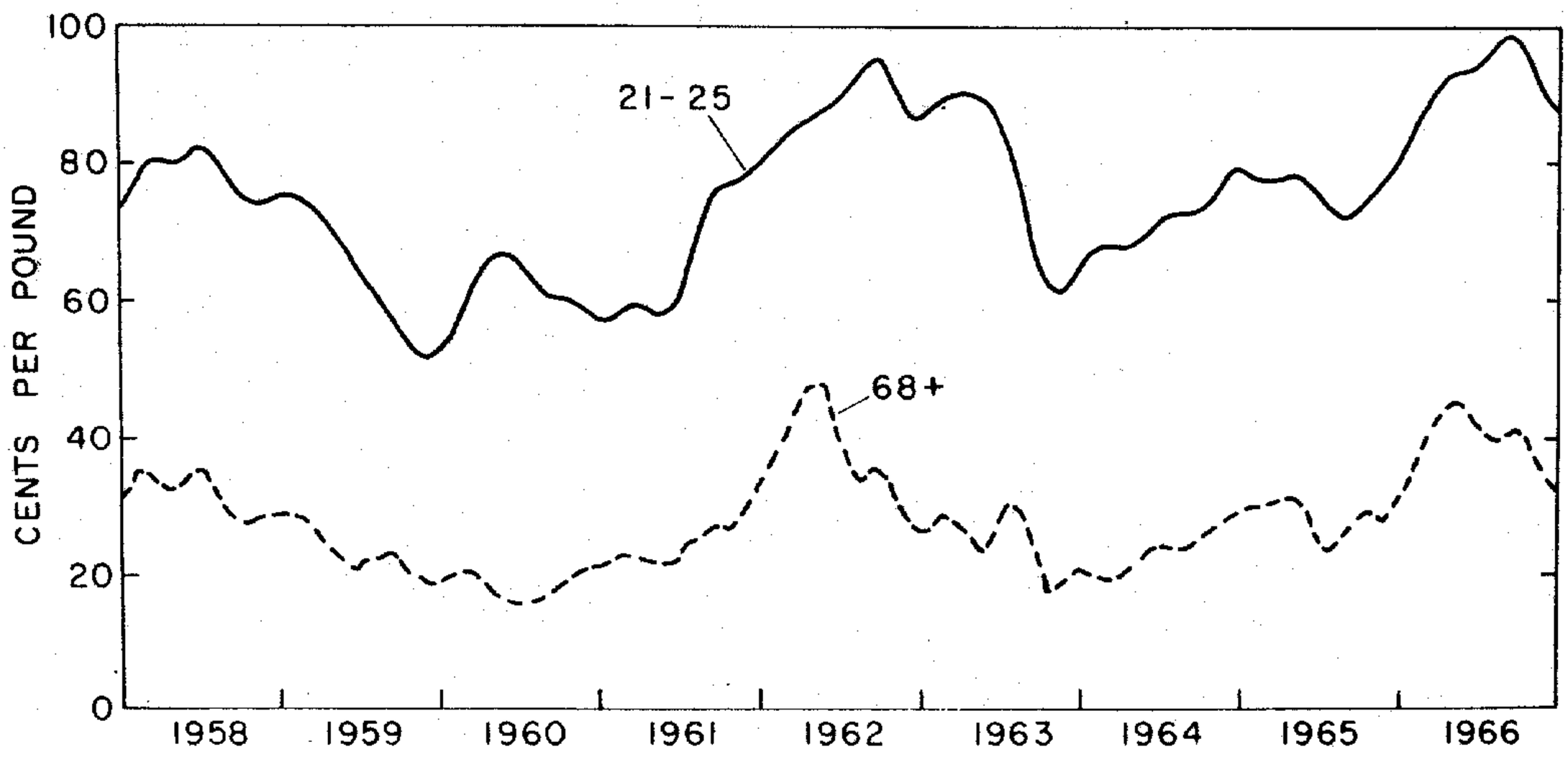

Fig. 2 Average ex-vessel price paid for small (68 or more per lb) and large (21 to 25 per lb (46 to 55/kg)) pink shrimp at ports on the west coast of Florida, 1958-66. (Original data smoothed by a moving average of three). Source: Shrimp Landings, Current Fishery Statistics, U.S. Fish and Wildlife Service.

ber of shrimp per lb, i.e. fewer than 15, 15-20, 21-25, ..., and value increases with size. The size composition of a landing is determined by either box or machine grading, depending on the facilities available and the fisherman's preference. In box grading, several 5-lb samples of shrimp are taken as a vessel is unloaded, and the size category assigned to the landings is based on the average number of shrimp in these samples. In machine grading the shrimp in the entire catch are mechanically sorted into a number of size categories.

When catches consist of a mixture of small and large shrimp, fishermen can influence the total value of a landing by selecting the method of grading that produces the greater revenue and, sometimes, by culling small shrimp. If the entire catch is box graded, the presence of small shrimp depresses the average size and the price per lb. To avoid this, a fisherman can separate large and small shrimp before reaching port and have each portion box graded. When the value of small shrimp is low, however, he may prefer to keep only large ones and discard the others. The fisherman is not penalized by the presence of small shrimp if he elects to have a landing graded by machine, but the total value of the landing may be less than if it were box graded.

2.4 Minimum size regulations

Each of the five Gulf states currently restricts the minimum size of shrimp that may be landed. Regulations differ considerably among states and no size limits apply during specified seasons in some areas. It is permissible for about 5 percent of the shrimp in a landing to be of sublegal size in situations governed by regulations.

3 OBSERVATIONS OF DISCARDING AT SEA

Biologists from the Bureau of Commercial Fisheries Biological Laboratory, Galveston, Texas, made several trips aboard commercial shrimp vessels to measure the size of shrimp culled from catches. The usual procedure was for the biologist to set aside a portion of the catch with a shovel soon after the nets were emptied on deck. He then asked a member of the crew to select shrimp that would normally be kept from this part of the catch. Length measurements were taken of shrimp selected as well as those that would have been discarded by the fisherman.

Although trips were scheduled when small shrimp were available on the fishing grounds, discarding did not occur during all voyages. No shrimp were discarded at sea during two trips because the shrimp were not handled individually. When catches are large and contain relatively few fish, some fishermen save the entire catch and, if culling is required, it is done when the landing is graded at the dock.

Length-frequency distributions of shrimp culled or kept during trips to the Tortugas pink shrimp grounds (Florida) and to the Texas brown shrimp grounds are shown in Fig. 3. These data provide an indication of the variation in sizes of shrimp and proportion of catches discarded. Estimates of the percentage of the total shrimp catch discarded during these trips ranged from 0 to 45 percent in numbers and 0 to 29 percent in weight. No difference was apparent in discarding practices in the two areas, but our data were not sufficient to permit definite conclusions.

4 INTERVIEW SURVEYS

We also collected information about discarding practices by interviewing vessel captains as they landed shrimp from the Tortugas and Texas grounds. Interviews were obtained from September 1963 through September 1966 at Marathon and Key West, Florida, and from June through August 1964-66 at Freeport and Aransas Pass, Texas. Information received through the cooperation of fishermen included estimates of the weight of shrimp discarded during a trip and an account of where the discarding occurred.

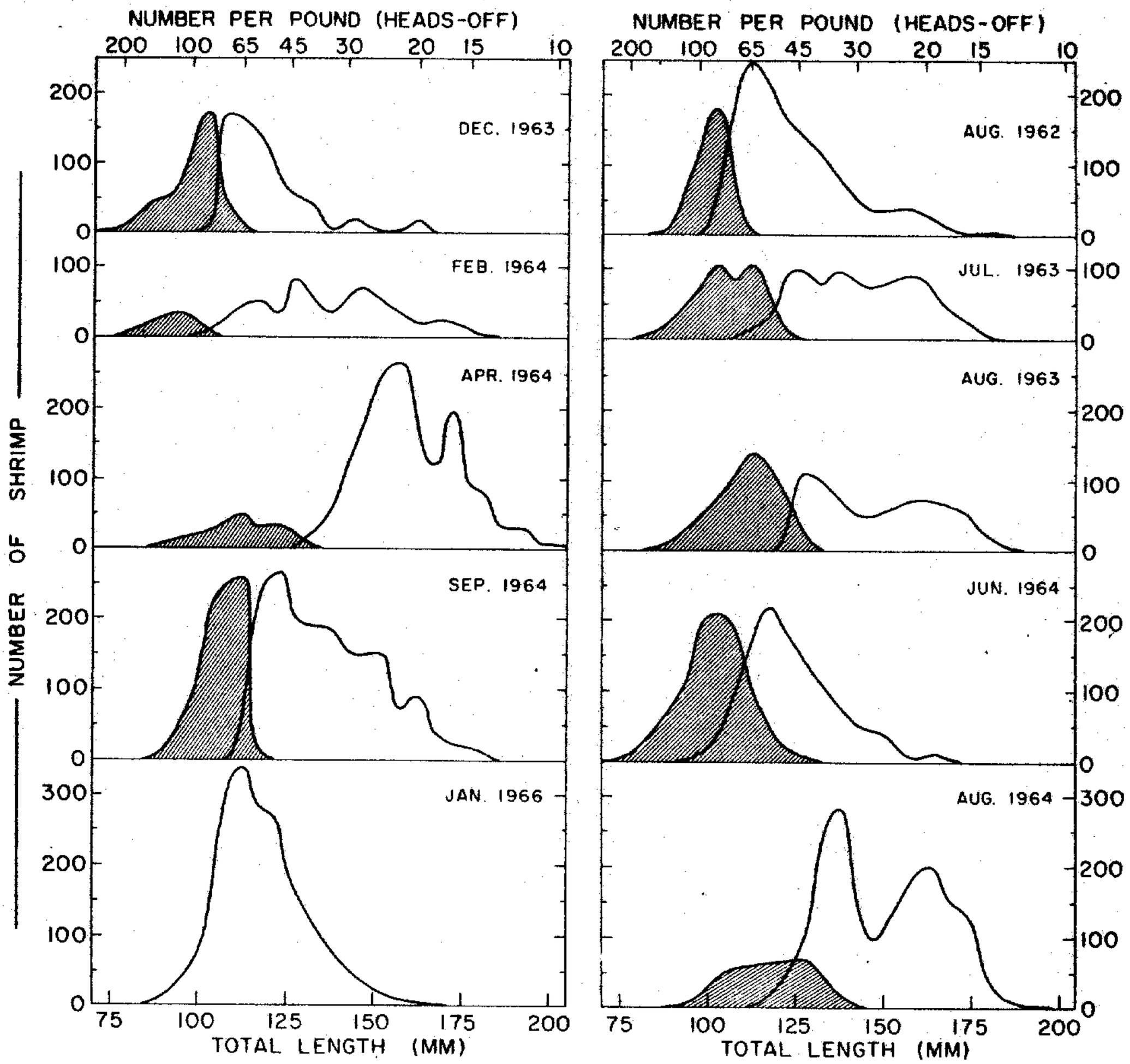

Fig. 3 Length-frequency distributions of shrimp that were culled and discarded (shaded areas) or kept (unshaded) during fishing trips to Florida and Texas fishing grounds.

4.1 Tortugas pink shrimp (Florida)

Interviews with fishermen at Key West and Marathon covered about 75 percent of the landings made at these ports and about half of the total landings from the Tortugas grounds. We have grouped the large volume of data that resulted into annual periods to facilitate presentation. Also, we assumed that the size of discarded shrimp was equivalent to that of shrimp sold in the size category of 68 or more per lb (150 or more /kg). This assumption made it possible to estimate the catch of small shrimp during a time interval and relate discarding practices to the abundance of small shrimp. We believe that the information provided by the fisherman was not biased.

An estimate of the total weight of shrimp discarded can be made from our information and that provided in "Gulf Coast Shrimp Data" (published by the Fish and Wildlife Service in the series entitled Current Fishery Statistics), a monthly tabulation of shrimp landings at United States ports in the Gulf of Mexico. The reported weight of shrimp landed and estimates of the weight discarded on the Tortugas grounds are listed in Table II for annual periods extending from October through September.

TABLE II

Estimated weight of headless shrimp discarded at sea, as indicated by interview data, and weight landed from the Tortugas grounds, October 1963-September 1966

Time period	Total weight landed	Estimated weight and percentage discarded		Percentage of landings covered by interviews
	(lb)	(lb)	(%)	(%)
Oct. 1963-Sept. 1964	11,187,926	789,800	6	40.0
Oct. 1964-Sept. 1965	10,051,716	140,700	1	53.3
Oct. 1965-Sept. 1966	13,153,024	28,200	<1	53.5

A marked change in discarding practices during the 3 years of our survey provided an opportunity to evaluate causative factors. According to fishermen interviewed, one-quarter to one-half of the small shrimp caught were discarded in late 1963, but, none were discarded during July-September 1966 (Fig. 4).

Because the size of shrimp increases from the shoreward edge of the fishing grounds toward deep water (Iversen, Jones and Idyll, 1960), we might expect the percentage of shrimp discarded to be greater in shallow than in deep water. The data showed, however, that the percentages did not vary directly with depth (Table III). Fishermen working in shallow water apparently were seeking small shrimp, whereas those fishing at greater depths were fishing for large shrimp and placed less value on small ones (Table IV).

Methods of grading shrimp landings and discarding practices were directly related (Table V). Discarding at sea was less frequent when landings were graded by machine than when the box grading method was used. We cannot distinguish whether shrimp were culled because of the type of grading that was to be used, or, if the method of grading was selected on the basis of the size composition of the landing. Both situations probably occurred. We also do not have information on culling from machine-graded landings during the grading process.

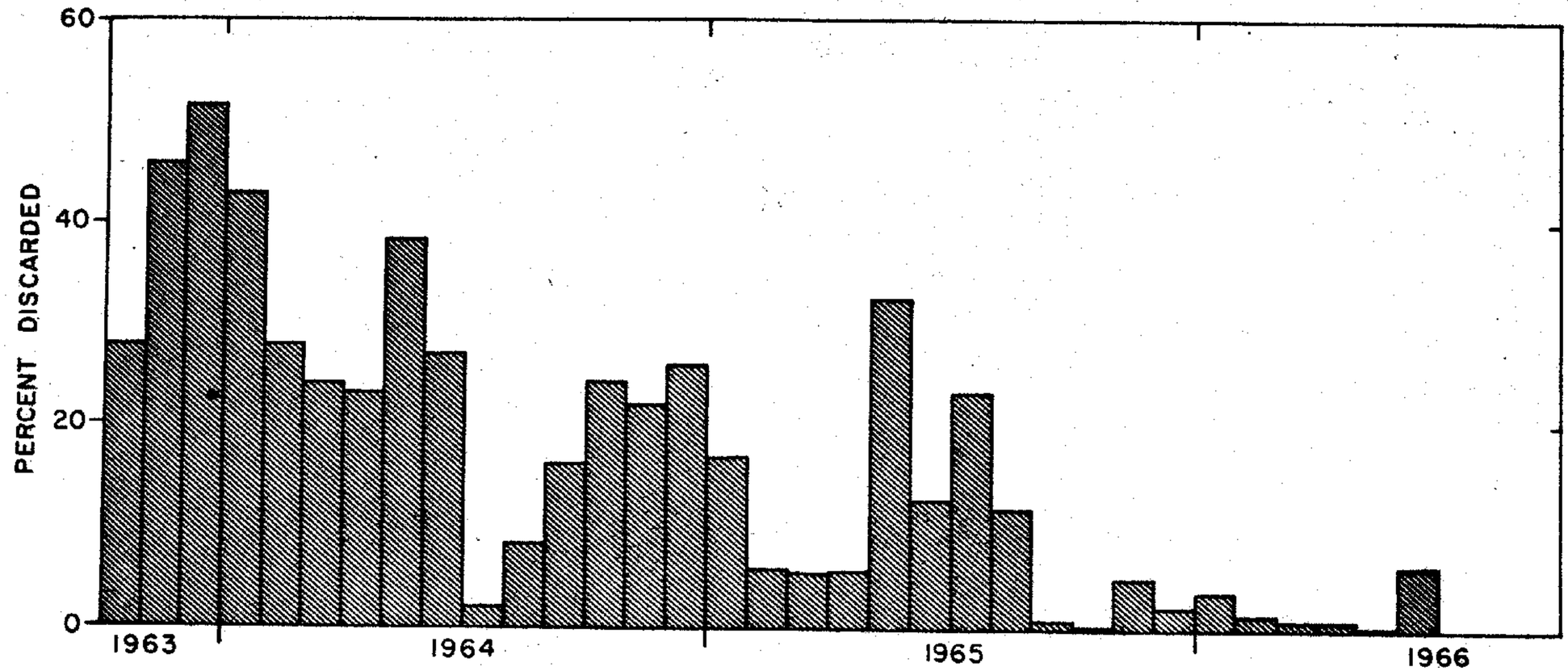

Fig. 4 Percentage (by weight) of small shrimp (68 or more per lb) discarded at sea on the Tortugas grounds, October 1963 to September 1966.

TABLE III

Percentage (by weight) of total shrimp catch discarded on the Tortugas grounds from October 1963 through September 1966, arranged according to depth intervals

Depth (m)	Oct. 1963-Sept. 1964	Oct. 1964-Sept. 1965	Oct. 1965-Sept. 1966
11-20	2.8	0.5	0.1
21-30	7.4	1.5	0.3
31-40	4.6	0.9	0.1
Over 40	2.8	0.4	0.0
Weighted mean	6.6	1.4	0.2

TABLE IV

Percentage (by weight) of small shrimp catch (68 or more per lb) discarded on the Tortugas grounds from October 1963 through September 1966, arranged according to depth intervals

Depth (m)	Oct. 1963-Sept. 1964	Oct. 1964-Sept. 1965	Oct. 1965-Sept. 1966
11-20	4.5	0.9	0.3
21-30	25.7	10.8	1.5
31-40	79.4	44.7	11.9
Over 40	71.7	46.5	0.0
Weighted mean	27.8	11.2	1.5

TABLE V

Frequency of discarding in relation to the method of grading shrimp landed from the Tortugas grounds, October 1963 - September 1966

Time period	Proportion of fishing trips during which shrimp were discarded					
	Machine graded			Box graded		
	Number of post-trip interviews	Interviewees who discarded shrimp No.	%	Number of post-trip interviews	Interviewees who discarded shrimp No.	%
Oct. 1963-Sept. 1964	349	42	12.0	2,650	1,124	42.4
Oct. 1964-Sept. 1965	958	28	2.9	2,681	408	15.2
Oct. 1965-Sept. 1966	904	8	0.9	3,306	62	1.9
Total	2,211	78	3.5	8,637	1,594	18.5

The statistical technique of multiple regression provides an objective means for evaluating effects of some factors that influence discarding. Two equations were formed to test data for the 36 months from October 1963 to September 1966, assuming that discards (Y) were a linear function of the independent variates (X_1, X_2, X_3).

$$(1)\quad Y = a + b\,X_1 + c\,X_2 + d\,X_3$$

$$(2)\quad \frac{Y}{Y + X_2} = a + b\left(\frac{X_2}{X_1}\right) + c\,X_3$$

Y = weight of shrimp discarded per month

X_1 = total weight of shrimp landed per month

X_2 = weight of small shrimp (68 or more per lb) landed per month

X_3 = price per lb for small shrimp (68 or more per lb).

The meaning of terms in equation (2) becomes more evident if symbols are replaced by words:

(2) (Proportion of small shrimp discarded) = a + b (proportion of small shrimp in landings) + c (price per lb for small shrimp).

The two equations provided similar answers to the question - Which factor (or factors) influences discarding practices? The only significant relation in either equation was the dependence of discarding on the price paid for small shrimp. Equa-

tion (2) was superior to equation (1) and accounted for about 55 percent of the variation in weight of shrimp discarded. Equation (1) explained 42 percent of the variation in weight discarded. Elimination of the first independent variable in equation (2) indicates that price per lb accounted for 42 percent of the total variation. As indicated in Fig. 2, the value of small shrimp increased throughout the study period and this increase apparently influenced fishermen to retain them for sale. The relation between price and the proportion of small shrimp discarded appears in Fig. 5.

4.2 Texas brown shrimp

Information on discarding of shrimp in the Texas brown shrimp fishery is not directly comparable to that from the Tortugas area. Differences exist in the general nature of the fisheries, in laws governing harvests, and in the availability of small shrimp. The shrimp industry on the Texas coast is geared to handle shrimp of medium or large sizes, and some processors are reluctant to purchase small shrimp (O. H. Farley, personal communication). State laws also discourage fishermen from landing large quantities of small shrimp. Fishing grounds between shore and depths near 20 m are closed to commercial fishing when small shrimp are abundant, and a minimum size restriction of 65 headless shrimp per lb is in effect throughout the year. In further contrast to the situation on the Tortugas grounds, small shrimp are plentiful in offshore Texas waters only from about June through August rather than during most of the year (see Fig. 1).

Our data from interviews obtained at Texas ports represent such a small proportion of landings made during the summers of 1964-66 that we consider them inadequate for estimating the total weight of shrimp discarded. They do provide, however, an indication of the percentage of catches culled (Table VI) and the frequency of discarding (Table VII). A seasonal decline in discards is evident from June through August each year, but there is no indication of the major decrease from 1964 to 1966 that we observed in the Tortugas fishery. Since the value of small shrimp was similar in Texas and Florida during the months of interest (Table VIII), it appears that factors other than price control discarding in the Texas fishery. Presumably, these factors include the reluctance of processors to purchase small shrimp and the minimum size restriction.

TABLE VI

Percentage (by weight) of brown shrimp catches discarded on Texas offshore fishing grounds (20-40 m) during June-August, 1964 and 1965 [1]

Month	1964	1965
June	7.7	13.7
July	1.8	4.2
August	0.2	0.1

[1] Estimated weight of shrimp discarded was not obtained during interviews made in 1966.

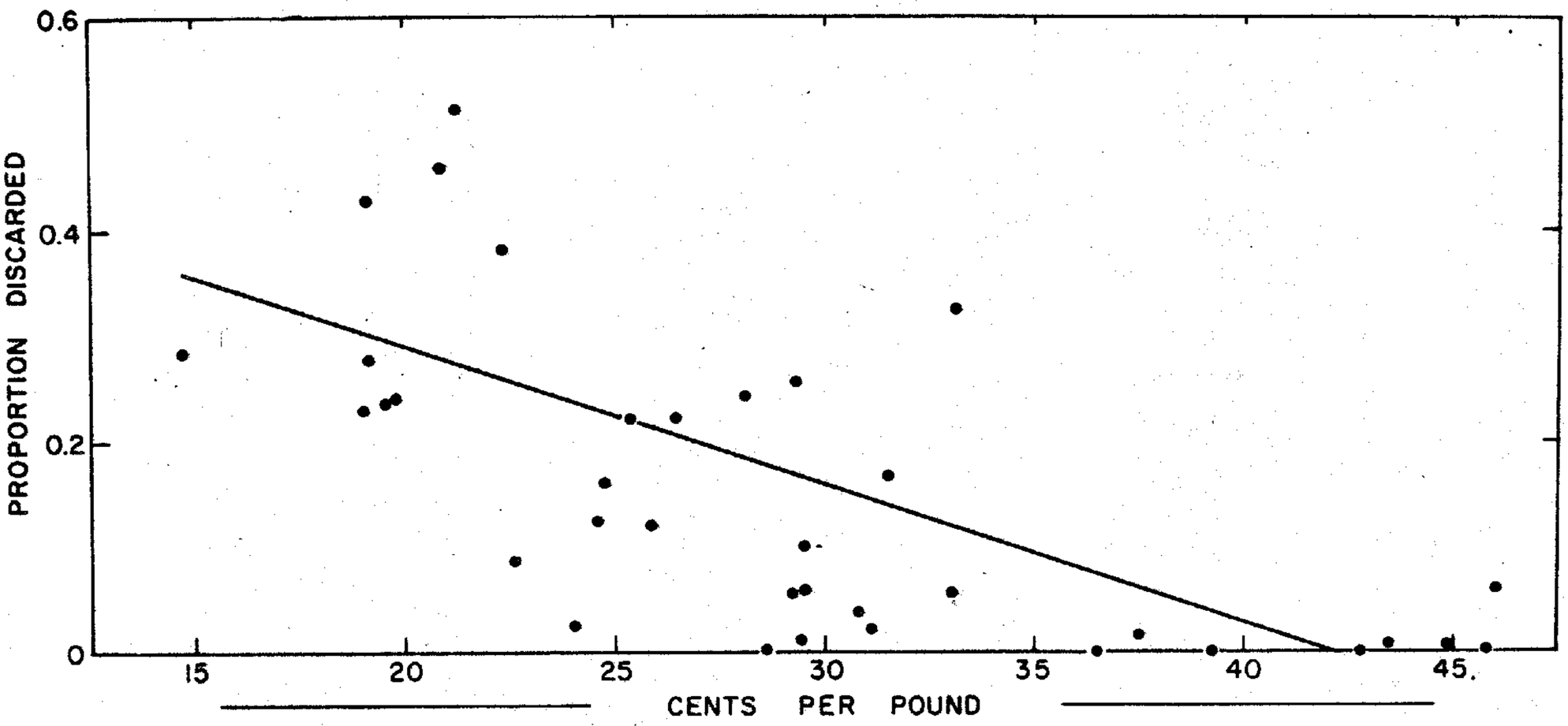

Fig. 5 Proportion (by weight) of the small shrimp catch discarded on the Tortugas grounds as related to their value, October 1963 to September 1966.

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TABLE VII

Frequency of discarding during fishing trips to the brown shrimp grounds (20-40 m) off the Texas coast, June-August 1964-66

Year and month	Number of post-trip interviews	Interviewees who discarded shrimp	
		Number	Percentage
1964			
June	246	81	32.9
July	694	115	16.6
August	860	35	4.1
1965			
June	229	104	45.4
July	793	219	27.6
August	676	31	4.6
1966			
June	127	35	27.6
July	323	25	7.7
August	292	16	5.5
Total	4,240	661	15.6

TABLE VIII

Average ex-vessel price (cents) per lb paid for small shrimp (68 or more per lb) at Texas and Florida ports in the summers of 1964-66

Month	1964		1965		1966	
	Texas	Florida	Texas	Florida	Texas	Florida
June	25.0	25.3	17.9	24.5	25.2	39.2
July	28.4	24.0	23.1	19.6	33.0	36.5
August	27.3	22.6	29.9	25.8	42.0	46.0
Average	26.9	24.0	23.6	23.3	33.4	40.6

5 MORTALITY OF DISCARDED SHRIMP

The fate of shrimp discarded at sea is important to an evaluation of culling practices. If the shrimp die, the practice is wasteful, but if they survive, it may have little significance. Shrimp culled from catches remain on the deck of commercial vessels for about 15 to 30 min before they are shoveled overboard. Cursory observations made aboard vessels suggested that most of the shrimp died within this period unless air temperatures were low.

To obtain additional information, we exposed shrimp to air at several temperatures in the laboratory and recorded resulting mortalities. The experiments were conducted in constant temperature rooms after the shrimp had been acclimated for a minimum of 2 days. About equal numbers of brown and pink shrimp measuring from 60 to 130 mm (tip of rostrum to tip of telson) were used in each test. The tests consisted of removing shrimp from sea water tanks and placing them on damp boards for different periods of time. They were then returned to the water and their condition was noted 5 min later. If they appeared normal at that time, we considered that they had survived the experience. Results from several experiments are summarized in Table IX.

These tests suggest that at least half of the shrimp discarded during normal fishing operations die from effects of exposure to air when temperatures reach 20°C. Air temperatures above this level prevail over the Tortugas and Texas fishing grounds (Fig. 6) during times when small pink and brown shrimp are most abundant (Fig. 1). If mortality from other causes such as injuries or predation is also considered, it is probable that very few of the discarded Tortugas pink or Texas brown shrimp survive.

TABLE IX

Mortality of brown and pink shrimp during exposure to air

Air and water temperature	Number of shrimp tested	Period of exposure to air	Mortality
(°C)	(No)	(Min)	(%)
15	27	15	4
15	26	30	12
15	29	45	41
15	35	60	77
23	81	15	78
23	37	30	100
27	25	15	96
30	25	15	100

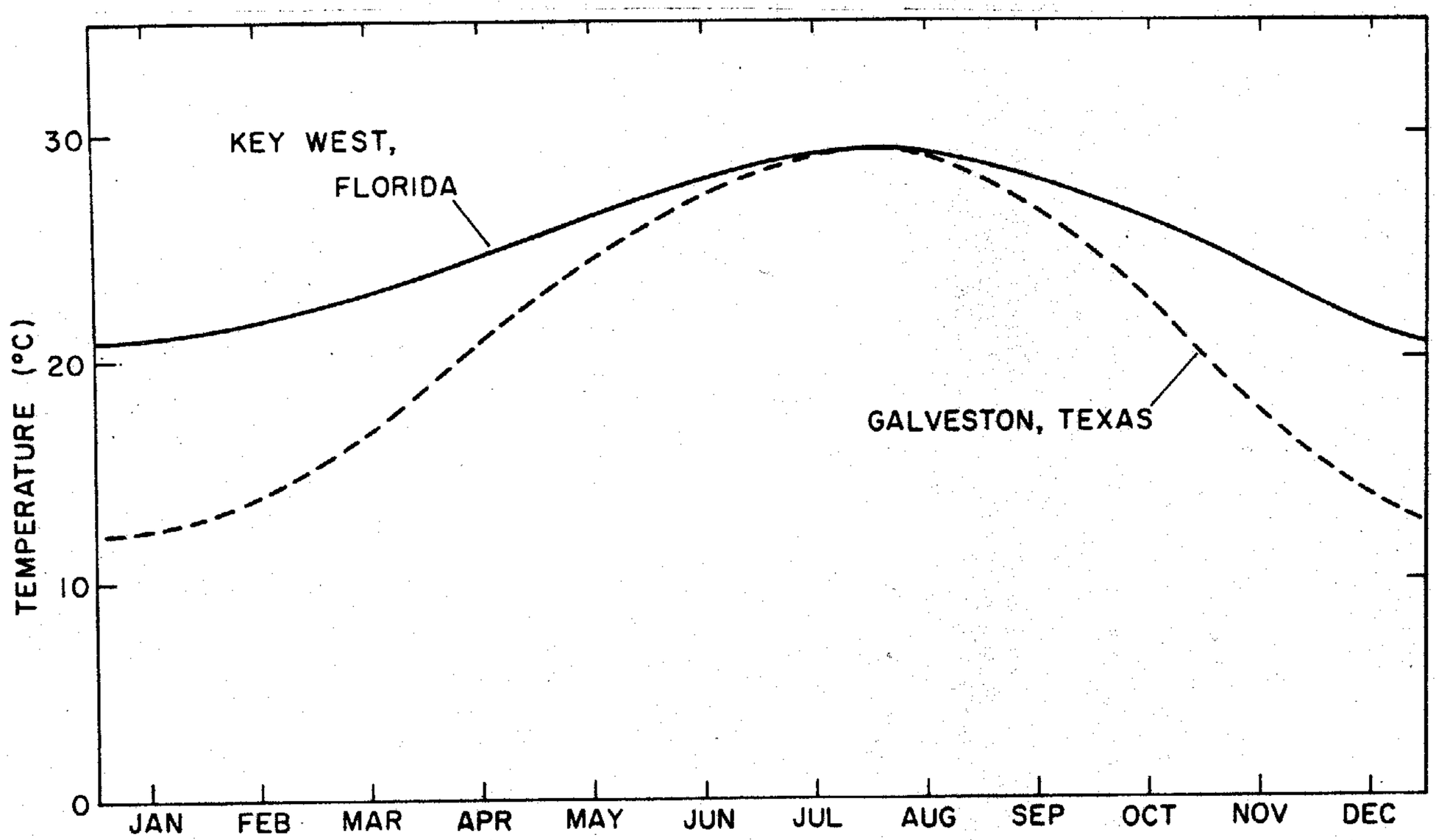

Fig. 6. Average monthly air temperatures at Key West, Florida and Galveston, Texas.
Source: Local Climatological Data. Weather Bureau, U.S. Department of Commerce.

6 CONCLUDING REMARKS

For analytical purposes, we have considered the practice of discarding small shrimp separately from most other facets of the shrimp fishery. This approach is convenient for gaining insight into the subject, but does not provide a satisfactory perspective from which to judge the significance of discarding. A realistic appraisal of its importance should be based on broad knowledge of the dynamics of both the shrimp populations and the market. Such information is not presently available.

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